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What Makes Some People Think Astrology Is Scientific?

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Abstract

Citizens in both North America and Europe are apt to read horoscope columns in newspapers and magazines. While some people read these casually and purely for entertainment, some believe that astrology has scientific status and can provide real insight into events and personality. Using data from a European survey, this article explores some of the reasons why some people think that astrology is scientific and how astrology is viewed in relation to other knowledge-producing practices. Three hypotheses in particular are tested. The first is that some Europeans lack the necessary scientific literacy to distinguish science from pseudoscience. The second is that people are confused about what astrology actually is. The third is derived from Adorno's work on authoritarianism and the occult and postulates that those who adhere to authoritarian values are more likely to believe in astrological claims. Support is found for all three hypotheses.

Keywords

quantitative analysis, public understanding of science, pseudoscience, astrology, authoritarianism

Introduction

Anyone reading this article is likely at some point to have read their horoscope. Astrology columns are widespread in print media and on the Internet

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and have been a staple for a surprisingly long time. One of the earliest recorded columnists was 17th-century astrologer William Lilly, who may have predicted the Great Fire of London, albeit 14 years early (Curry, 1989). Webster-Merriam dictionary defines astrology as "divination of the supposed influences of the stars and planets on human affairs and terrestrial events by their positions and aspects." A horoscope, on the other hand, is defined as a "diagram of the relative positions of planets and signs of the zodiac at a specific time (as at one's birth) for use by astrologers in inferring individual character and personality traits and in foretelling events of a person's life." The more common understanding of horoscopes is that they are astrological forecasts, such as those that appear in newspapers. It is this definition that I use for the rest of the article. Ten years ago, just less than half of Americans read their horoscope at least occasionally in 1999 (National Science Board, 2000), and there is little reason to think that the numbers have declined since then.

It is one thing to read an astrology column for amusement or entertainment but quite another to believe that astrological predictions about events or personality will come true. A surprisingly large quantity of scientific research has been carried out to evaluate the claims of astrology. Less surprisingly, there is really no evidence to support such claims (Blackmore & Seebold, 2001; Carlson, 1985; Eysenck & Nias, 1982). It is therefore cause for concern if citizens make important life decisions based on entirely unreliable astrological predictions. For instance, people may decide for or against a potential marriage partner based on astrological sign, they may make rash financial decisions based on predicted good fortune, and so on. For this reason, in 1984, the Committee for Skeptical Inquiry (at that time the Committee for Scientific Investigation of Claims of the Paranormal) began a campaign to persuade American magazines and newspapers to attach a "health warning" to horoscope columns to indicate that they were to be read for entertainment purposes only. Only around 70 publications out of 1,000 or more in the United States that carried horoscopes at that time agreed to carry such a warning. This probably indicates that newspaper proprietors do not want to spoil their readers' enjoyment by telling them that they should really ignore all the advice given. In any case, since the 1980s, there has been a proliferation of horoscope and astrology-related websites, such as horoscope.com. This attests not only to the popularity of the topic but also to the impossibility of policing the way in which information is presented to the public.

But perhaps people do not set any store by astrological predictions and a health warning is really not necessary. After all, one does not need to believe something is true to be entertained by reading it. However, it appears that

belief in astrological claims is quite widespread, at least in the United States. Losh and colleagues, in a review of 20 years of the U.S. survey data, found that many Americans believed in astrology, with polls putting the figure at around 25% (Losh, Tavani, Njoroge, Wilke, & Mcauley, 2003; National Science Board, 2002).

Astrology and Science

Why should the credulity of some sections of the public toward astrology be a matter for concern for science communicators? Even if people do believe in astrology, or ghosts and alien abductions for that matter, does this have a bearing on people's understanding of and engagement with science? Again, the evidence is that it probably does. For not only do sizeable proportions of the American and European public believe in the efficacy of astrology, they also believe that it is scientific (National Science Board, 2006). The ability of citizens to distinguish between scientific and pseudoscientific claims is seen by many as an important component of scientific literacy. In a social and economic environment increasingly permeated by science, and the technological developments that flow from it, citizens require some basic competencies in order to meaningfully engage in rational judgments about a whole host of issues. For example, climate change, biofuels, stem cell cloning, synthetic biology are all topics that have acquired, or are quickly gaining, political status, which in turn require societal decisions to be made. In Miller's framework for measuring civic scientific literacy, the rejection of astrology is an empirical criterion for identifying those who are and are not scientifically literate (Miller, 2004). Surveys in Europe and the United States have tracked public beliefs about astrology and science since 1988. In the United States, respondents have been asked whether astrology is "very scientific, sort of scientific, or not at all scientific." Around 60% said astrology is not at all scientific with around 30% saying it is "sort of scientific" in seven surveys between 1988 and 2001. In 2004, the proportion rejecting astrology rose slightly, to 66% (National Science Board, 2006). In Europe, there appears to be more widespread belief that astrology is scientific. In 1992, respondents were asked how scientific they thought astrology was, with a 5-point scale anchored at either end with *very scientific* or *not at all scientific*. Only one quarter considered astrology *not at all scientific*, with another quarter considering it *very scientific* and the remaining respondents falling somewhere in between (INRA, 1993). In 2001, the question was asked in a slightly different way, with only two response options offered— *rather scientific* or *not scientific*. Fifty-three percent thought astrology was *rather scientific* (European Commission, 2001a).

The evidence, then, suggests that a sizeable minority of Americans and an even greater proportion of Europeans believe that astrology in some sense "works," either because it is based on scientific methods or for other reasons. What might account for this widespread belief? And more interestingly, perhaps, what might explain differences in degree of belief in astrology between individuals and groups?

Most research on astrology as been focused on directly evaluating its claims but there is a stream of research on the psychological foundations of belief in pseudoscience. Integrating much of this work, Lindeman (1998) proposes two key reasons why pseudoscientific claims can appear credible. First, motivation: astrology offers, at first blush, a way to comprehend and make sense of a complex and contingent world and also one's "inner life," personality, luck, and so on. It is attractive for that reason. Second, cognition: it often appears to be consistent with heuristic or "experiential" forms of cognitive processing, which makes it believable.

In terms of motivation to believe, astrological predictions are very often favorable. This makes them attractive, even to those who are skeptical of astrology (Dean, 1987; Glick, Gottesman, & Jolton, 1989). The use of astrology to explain personality and, for instance, to understand how to achieve success and control in personal affairs is a generally strong motivation for people (Baumeister & Leary, 1995). In terms of the way evidence is cognized, there are many well-established findings showing that people tend to use information shortcuts that are easy and quick to process that facilitate decision-making and judgment (Kahneman, Slovic, & Tversky, 1982). One of the clearest forms of heuristic cognition in relation to astrology is confirmation bias (Fiske & Taylor, 1991; Ross & Anderson, 1982). This underlies the "Barnum effect." Named after the 19th-century showman Phileas T. Barnum, whose circus act provided "a little something for everyone," it refers to the idea that people will believe a statement about their personality that is vague or trivial if they think that it derives from some systematic procedure tailored to especially for them (Dickson & Kelly, 1985; Furnham & Schofield, 1987; Rogers & Soule, 2009; Wyman & Vyse, 2008). For example, the more birth detail is used in an astrological prediction or horoscope, the more credulous people tend to be (Furnham, 1991). However, confirmation bias means that people do not tend to pay attention to other information that might disconfirm the credibility of the predictions.

The fact that people tend to assume that the more complex the information used as input into astrological readings, the more accurate the predictions are perhaps points to the informal reasoning that people use in mistaking astrology for science. "It sounds complicated—it must be scientific!"

The Present Study

There is evidence, then, of the general and widespread reasons why pseudoscience, and astrology in particular, might garner public credibility. Most of this evidence is small scale and experimental, with very little based on large population surveys. Rather, less is known about the causes and correlates of heterogeneity of belief about astrology. The present study sets out to evaluate several potential explanations for variation in the credibility given to astrology *qua* science by European citizens, using a recent Eurobarometer survey. In doing so, I also examine how astrology is viewed alongside other knowledge generating practices, scientific or otherwise, in order to understand where astrology is located in the European public's representational field. In the following sections, I briefly outline some putative factors that I consider might account for variation in citizens' beliefs before describing in more detail the data and methods used for the empirical analysis.

The "immunization" hypothesis. From a traditional science communication perspective, it is scientific knowledge, particularly knowledge of the methods of science, that would be expected to "immunize" citizens against false belief in pseudoscience. Hence, those who are more scientifically literate, who understand principles of experimentation, the combining of empirical evidence with logical inference, and so forth should be more likely to realize that astrology, for all its formalistic presentation, is not consistent with the tenets of scientific method. The survey evidence broadly supports this hypothesis, albeit indirectly. In both Europe and the United States, correlates of skepticism about astrology's "scientificness" tend to be higher levels of education, higher social class, and higher income although there is some inconsistency between surveys. In 1992, Eurobarometer surveys showed that more highly educated Europeans were less likely to think that astrology is scientific, whereas in 2001, this was not the case (European Commission, 2001a). In the United States, education has been a consistent predictor. For example, the most recent National Science Foundation data show that while 84% of college graduates think that astrology is not at all scientific, just 62% of those who only graduated from high school share this belief (National Science Board, 2008). Education is not, of course, coterminous with scientific knowledge, but it is strongly correlated (Allum, Sturgis, Tabourazi, & Brunton-Smith, 2008; Miller, 2004). Income and social class are themselves invariably correlated with education. Examining the relationship between scientific knowledge and belief in astrology as a science net of education, income and social class, would be a stronger test of the "immunizing" hypothesis, and one that I test in this article.

What's in a name? One of the better established findings in survey measurement is that responses can be extremely sensitive to the particular form of words used in the asking of the question (Schuman & Presser, 1996). In the European surveys reviewed earlier, the English version of the questionnaire uses the word "astrology" as the stimulus object of the item:

> People can have different opinions about what is scientific and what is not. I am going to read out a list of subjects. For each one tell me how scientific you think it is by the scale on this card . . . [other subjects] . . . . Astrology.

It is possible that people are unfamiliar with the this term but may be more familiar with terms like *horoscopes*, *star signs*, *sun signs*, which, if asked how scientific they are, might elicit different results. In fact, there is some evidence on this from the 1992 Eurobarometer survey. Respondents were randomized to two different versions of the list of subjects. One simply contained the single word, as above, while in the other condition, a brief explanation of each subject was given. For astrology, the explanation was the following: ". . . that is the study of occult influence of stars, planets etc. on human affairs." There was no significant difference in responses between the two conditions (INRA, 1993). However, in most European languages the suffix "ology," "ologie," "ologia" connotes an academic field of study. This may be enough to encourage respondents to think that astrology is indeed a science where the use of an alternative term may bring to mind a different kind of activity. Another hypothesis that has intuitive plausibility, but which has not previously been tested, is that many people mistake astrology for astronomy—a simple semantic confusion. The extent to which this might occur is also likely to vary across countries according to the similarity of the two terms in different languages.

The stars down to earth. The explanations just outlined for belief, or apparent belief, in the scientificness of astrology are, in one form or another, based on deficits of understanding and information. There may be other reasons why some people more than others place faith in astrological predictions. One of the most interesting social psychological viewpoints on this question is found in the work of Theodor Adorno. In 1952-1953, Adorno carried out a study of Caroll Righter's *Los Angeles Times* astrology column. The fruits of this did not appear in English until published in *Telos* in 1974 as "The stars down to earth" (Adorno, 1974). In the study, referred to by the author as a "content analysis," Adorno analyses, somewhat haphazardly and selectively, the advice given to readers in the column over a period of several months. He identifies many of the aspects of astrological readings that other psychological

research (e.g., Forer, 1949) confirmed were effective in making them convincing: the Barnum effect, the tendency to personalize general statements and so forth. He is witheringly critical of astrology, dubbing it, with the rest of occultism, a "metaphysic of dunces" and suggesting that "a climate of semierudition is the fertile breeding ground for astrology" (Adorno, 1994, p. 44). The claim is that it resembles other "irrational creeds" like racism by offering a shortcut to (erroneous) knowledge, which actually requires no intellectual effort or capacity (Dutton, 1995).

What is particularly interesting for the present study, though, is the connection drawn between astrology (and other forms of popular occultism) with authoritarianism, fascism, and modern capitalism. Adorno sees astrology as emphasizing conformity and deference to higher authority of some kind. Nederman and Goulding (1981) sum this up concisely as "Take things as they are, since you are fated for them anyway." Adorno posits an "astrological ideology" that he claims "resembles, in all its major characteristics, the mentality of the 'high scorers' of the Authoritarian Personality" (Adorno, 1994). The work on "Authoritarian Personality" by Adorno and colleagues has been much criticized since its appearance in 1950 (Adorno, Frenkel-Brunswik, Levinson, & Sanford, 1950; Kirscht & Dillehay, 1967) with particular criticism being directed toward the test items in the "F-Scale" (Hyman & Sheatsley, 1954). Nevertheless, it is possible to deduce a reasonably clear empirical hypothesis from "stars down to earth." Those who value conformity, obedience, and tend toward uncritical acceptance of in-group moral authority will be more likely to give credence to the claims of astrology.

Adorno also discusses the relationship of organized religion, or religious belief with astrological belief. He suggests that part of astrology's appeal is that it formalizes the notion of some higher authority at work controlling life events yet does not come with the explicitly restrictive structure of formal religious adherence, churchgoing, and so on. This is part of what, for Adorno, makes astrological belief and capitalist individualism such well-suited bedfellows. That is to say that religious belief and astrological belief are both consistent with the same authoritarian trait of personality. If this is true, one might expect beliefs about astrology and about religion or God to be related.

Hypotheses and Questions

The foregoing discussion leads to the derivation of the following hypotheses:

Hypothesis 1: The suffix "ology" means that people should tend to rate "astrology" as more scientific than "horoscopes."

Hypothesis 2a: Because of potential confusion or elision of meaning between "astronomy" and "astrology," we should expect there to be a positive correlation between how people rate the scientificness of these two subjects.

Hypothesis 2b: Assuming Hypothesis 2a to be correct, we should not expect to see the same positive correlation between ratings of horoscopes and astronomy because the potential for semantic confusion is much less.

Hypothesis 3C: Citizens who are more knowledgeable about science should be less likely to rate astrology as scientific.

Hypothesis 4: Following Adorno's thesis, we should expect that people who score higher on a measure of authoritarianism will be more likely to rate astrology as being scientific.

In addition to the evaluation of these empirical expectations, there are two more general questions that are addressed in the analysis:

Question 1: How is astrology viewed by Europeans in relation to other scientific and nonscientific subjects?

Question 2: How much of the variability in beliefs about astrology across Europe is related to country of citizenship?

Data and Measures

Data

The data for this study come from the Special Eurobarometer 224 and 225 surveys, "Europeans, Science and Technology," "Social Values, Science and Technology" (European Commission, 2005a, 2005b). The author was part of the team that worked on the design of questionnaire. Both these survey modules were fielded as part of the same face-to-face interview to citizens in 25 EU member states during the fall of 2004. Approximately 1,000 respondents were interviewed in each country, using a multistage probability design. (For more details on the survey methodology, see European Commission, 2005a). The resultant data set contains rich information on citizens' beliefs, attitudes, and knowledge about science and technology, as well as on political and social values. Also embedded within the survey was a split-sample randomized question wording experiment.

Measures

The key dependent variable, belief in the scientificness of astrology, was measured by asking respondents how scientific they consider each of ten subjects to be, on a scale from 1 to 5 where 1 indicates *not at all scientific* and 5 indicates *very scientific*. As part of the list of 10 subjects a randomized half of the sample was asked about "astrology" and the other half about "horoscopes." The other 9 subjects were physics, medicine, astronomy, economics, history, homeopathy, psychology, biology, and mathematics. (The exact question wordings and response alternatives for the English questionnaire for all the measures employed can be found in European Commission, 2005a, 2005b.)

Authoritarian values are measured with a single indicator. While this is a good way short of ideal in terms of best practice in measurement, the question employed has what appears to be good face validity. Respondents are shown a list of qualities that children should be encouraged to learn. One of these qualities is "obedience." Responses to this item are on a 4-point scale ranging from *not at all important* to *very important*. This battery of items was designed to tap into a range of values, including authoritarian values, with the item utilized here. Measuring this construct with a question that essentially taps social conformity accords with recent work in political psychology (Feldman, 2003). Child rearing goals that value obedience have also been shown to be related to authoritarianism (Danso, Hunsberger, & Pratt, 1997). So while this single indicator is by no means perfect, I consider there is sufficient reason to consider it adequate for purpose here.

Also related to Adorno's work on authoritarianism is religious belief. To capture this, I use an item that asks whether a respondent believes in "God," a "spirit," or neither. From this categorical variable, two dummy variables have been derived, indicating belief in God or belief in a spirit (both vs. no belief). I also use a dummy variable indicating whether or not the respondent is Catholic. Around 80% of the sample are Christians of some type, with Catholics making up around 50%. Distinguishing between Catholics and all others is a reasonable way of capturing the major source of religious denomination absence of any particular hypotheses about denomination-based differences in beliefs about astrology.[1]

Knowledge about science is measured in a number of ways in the survey and in the analysis I use three separate indicators. Two of these tap into respondents' understanding of scientific process and method. An understanding of

method is arguably central to being able to distinguish between scientific and pseudoscientific claims. People were asked "what does it mean to study something scientifically?" The verbatim responses were coded into one of several mutually exclusive categories, based on what was said (in other words, not precoded). Typically this question has been a very good predictor of attitudes and beliefs about science with the mention of hypothesis testing and experimentation as the critical component. Here I use this as an indicator of greater scientific understanding along with another indicator based on the mentioning of "measurement" in response to the question. The third indicator is a summated scale of correct responses to a series of 13 true/false quiz items that tap textbook type knowledge about scientific facts. For example, "the sun goes around the earth" and "lasers work by focusing sound waves." These items have long been used in public understanding of science surveys, having been developed originally by Jon Miller, John Durant, and colleagues (Durant, Evans, & Thomas, 1989; Miller, 1998). For the purposes of this analysis, "don't know" responses are coded with a zero, the same way as incorrect true/false answers. The scale has reasonable internal consistency with a Cronbach's alpha coefficient of .72.

A range of other background characteristics were measured in the survey and used in the analysis. Respondent age was coded in bands: 16 to 24, 25 to 39, 40 to 54, 55+. Occupational status was measured with a dummy variable contrasting white collar and management occupations with all others. This is a necessarily crude indicator as it is based on standardized Eurobarometer occupational coding that needs to be comparable across European states. However, as it is only being used as a control variable in the analyses that follow, it is not critical to obtain a more fine-grained estimate of the effects of occupational status on beliefs about astrology. Education is measured, again quite bluntly, with a variable that indicates whether or not the respondent left full-time education after the age of 20. This broadly distinguishes the graduate population, and it is this distinction that has in previous research been shown to be the most diagnostic of differences in attitudes and beliefs about science and technology (e.g., Miller, Pardo, & Niwa, 1997). Finally, the type of area in which the respondent lives is captured with a variable that indicates residence in a large town versus other types of area. Typically one might expect urban populations to have different cultural and political orientations to rural and provincial populations, net of education and occupational differences; hence, this variable is used as a control.

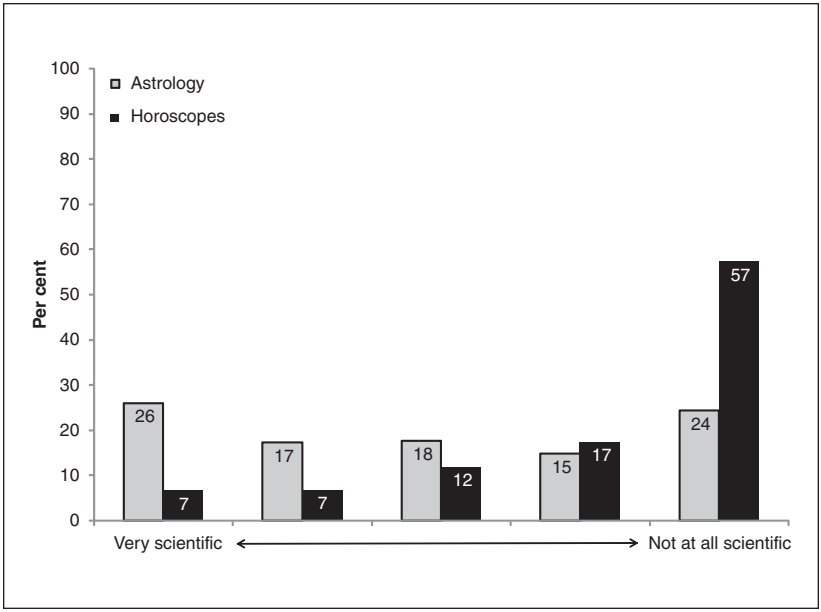

Figure 1. How scientific is astrology/are horoscopes?

Results

Question Wording Experiment

Figure 1 shows the response distributions for the two experimental conditions. In one condition, respondents were asked how scientific they thought astrology was and in the other how scientific did they think horoscopes were. Quite clearly, many more Europeans think astrology scientific than horoscopes. 57% think that horoscopes are "not at all scientific," while only 24% believe the same about astrology. About one quarter of the sample believe astrology to be "very scientific," while only 7% think that horoscopes are "very scientific." The difference in distributions is highly significant, $\chi^2 = 3{,}400$ (4 *df*), $p < .001$, $n = 23{,}473$). Astrology is clearly viewed as greatly more scientifically credible than horoscopes and this is in line with the expectations set out in Hypothesis 1. Another point to note is that the there is a great deal more heterogeneity in beliefs about astrology than about horoscopes,

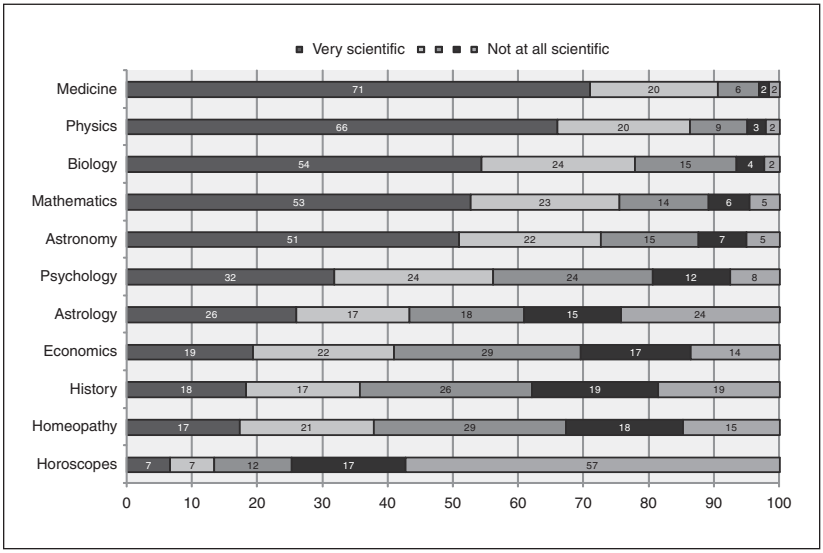

Figure 2. "Scientificness" of 11 activities (%)

with both "very scientific" and "not at all scientific" each attracting one quarter of all respondents.

The Relationship Between Astrology, Horoscopes, and Other Subjects

Figure 2 shows the distribution of European beliefs about the scientificness of all 11 subjects included in the questionnaire (including both horoscopes and astrology). The chart is ranked in descending order according to the percentage of people thinking each subject is "very scientific." As can be seen, the list includes a range of more or less scientific subjects, including both horoscopes and astrology, along with homeopathy, as examples of pseudoscience.

Medicine is viewed as the most scientific subject, followed closely by physics and then biology. Horoscopes are least likely to be thought "very scientific," followed by homeopathy, history, and economics (17%, 18%, and 19%, respectively). In most respects, this is not a surprising result. The natural sciences are at the top with social and behavioral subjects lower down. What is somewhat surprising, although in line with other surveys

(European Commission, 2001b), is that astrology is considered to be more scientific than economics and only just less so than is psychology.

Figure 2 suggests some ambivalence about the scientific status of astrology if not homeopathy and horoscopes. Hypothesis 3 predicts that those who are more scientifically literate will be less likely to regard astrology as scientific. In more general terms, one might expect a higher degree of understanding of science to confer greater ability to discriminate between science and pseudoscience in general. Later in the article I shall return to this hypothesis in a multivariate setting but it is interesting to see what happens when the result in Figure 2 is stratified by scientific knowledge. The number of correct answers given by each respondent was used as an indicator of science literacy that runs from 0 to 13. Figure 3 plots the percentage of Europeans selecting "very scientific" or the scale point below at each successive level of scientific knowledge. Also plotted out of interest is the percentage agreement with another the statement in the questionnaire that arguably taps into superstitious beliefs "some numbers are lucky for some people."

The plot shows that there is a noticeably steep negative gradient with scientific knowledge for belief in the pseudosciences homeopathy, astrology, and in lucky numbers. For instance, between 50% and 60% of citizens scoring 3 out of 13 on the knowledge quiz believe in the scientific credibility of homeopathy and astrology, and believe in lucky numbers. That percentage drops to just 15% to 25% for those that obtain a maximum score on the knowledge quiz. In contrast, for both medicine and psychology, which, recall, are quite a long way apart in the rank ordering shown in Figure 2, there is little or no difference between the beliefs of the better or worse informed citizen. (The lines for physics, biology, and mathematics are similar to that for medicine and are not shown here, in order to keep the graph intelligible.)

A further exploration of the basis on which Europeans make judgments about the scientificness of these subjects was carried out using factor analysis. Two separate analyses, one for each split half of the sample, were performed using maximum likelihood estimation and oblique rotation. Table 1 shows the factor loadings for the three-factor model that resulted, based on an examination of the scree plot and substantive interpretability. An obliquely rotated solution was preferred because I assume that there are individual differences in the propensity to agree or disagree that any subject is scientific, as well as a tendency to discriminate between groups of similar subjects. This carries the implication that all factors are likely to be correlated to some degree, given that "how scientific . . ." is in the stem of all the questions. In any case, the assumption of correlated factors is weaker than assuming that they are orthogonal to each other, so is preferred here.

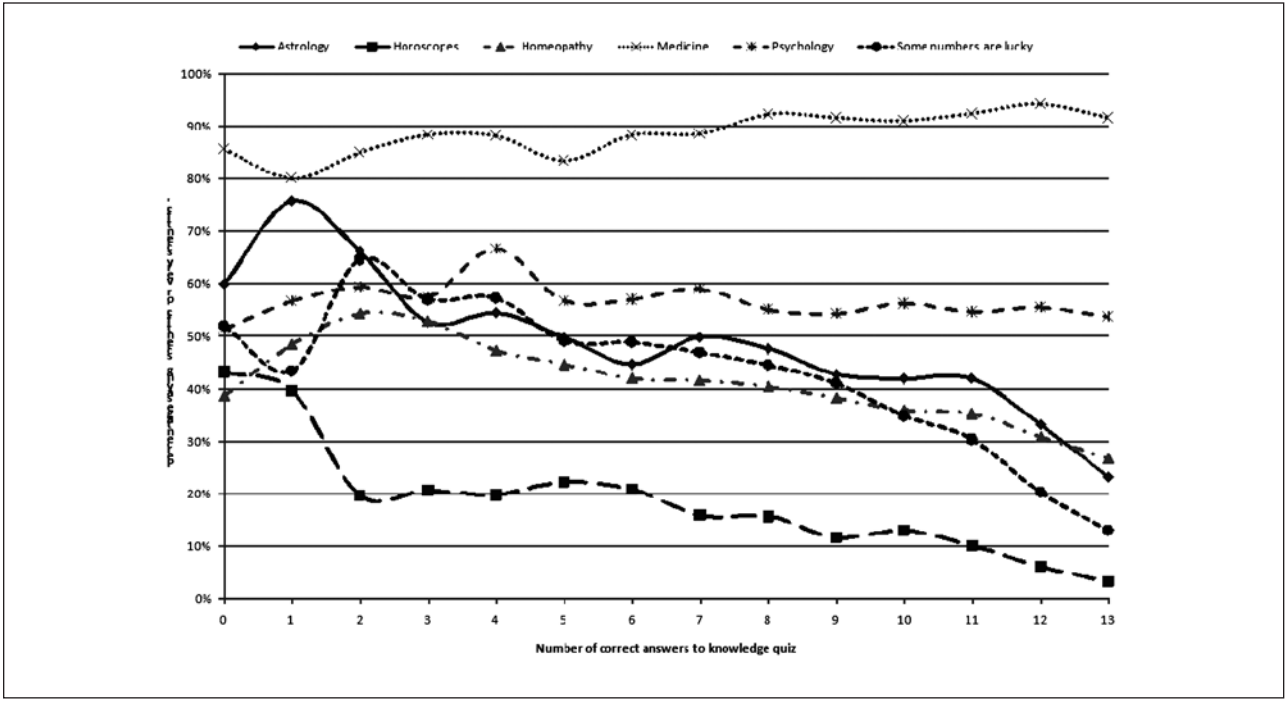

Figure 3. Beliefs about "scientificness" versus science knowledge

Table 1. Three Factors Underlying Perceptions of Scientificness (Astrology Condition)

	Rotated Factor Pattern Loadings (Total Variance Explained 42%)		
	"Hard Science" (28%)	"Soft Science" (9%)	"New Age Science" (4%)
Physics	0.88	–0.07	–0.12
Biology	0.61	0.00	0.04
Medicine	0.58	–0.01	0.12
Astronomy	0.49	–0.02	0.11
Mathematics	0.49	0.29	–0.12
Economics	0.02	0.71	0.01
History	–0.03	0.62	0.06
Homeopathy	0.00	0.07	0.62
Astrology	0.03	–0.02	0.44
Psychology	0.11	0.32	0.37

Note: Oblique rotation, maximum likelihood.

I have labeled the three factors "hard science," "soft science" and, for want of a better term, "new-age science." The highest factor loading for "hard science" is physics at 0.88, while the "soft science" includes economics and history, anchored by economics, at 0.71. Homeopathy, astrology, and psychology form a "new-age science" group, although psychology has a weak cross-loading with "soft science." The reason for the "new age" label is that the three subjects that load on this factor are the kind of subjects that people might expect to see in the self-help, pop-psychology, or new age therapy sections of bookstores. The representation of psychology for the European public is perhaps less about, for instance, cognitive neuroscience and more about self-help for overcoming depression.

In Table 2, the rotated solution for the sample that were asked about horoscopes is presented. The main difference is that only two factors are needed to describe the cognitive structure organizing responses to the 10 subjects. There is no separate "new-age science" dimension, with horoscopes, homeopathy, and psychology joining history and economics to form a "soft science" group. The "hard science" subjects remain the same, with physics again anchoring the factor with the highest loading, at 0.78.

Table 2. Two Factors Underlying Perceptions of Scientificness (Horoscopes Condition)

	Rotated Factor Pattern Loadings (Total Variance Explained 36%)	
	"Hard Science" (26% Variance)	"Soft Science" (10% Variance)
Physics	0.78	–0.11
Biology	0.63	0.05
Medicine	0.60	0.03
Mathematics	0.52	0.17
Astronomy	0.52	0.09
History	0.12	0.55
Economics	0.17	0.52
Psychology	0.26	0.50
Horoscopes	–0.30	0.48
Homeopathy	0.08	0.43

Note: Oblique rotation, maximum likelihood.

The results seen thus far indicate fairly unequivocally that while horoscopes and astrology are to all intents and purposes the same thing, at least in so far as the casual engagement of the average citizen is concerned, the two terms have rather different connotations. Astrology probably "sounds" more scientific than horoscopes; it is consequently evaluated as being more scientific and is viewed in a more similar way to psychology and homeopathy than are horoscopes. Having elaborated a description of how astrology is perceived, the following section turns to the question of what might underlie the variation in these perceptions among citizens and across European states.

Variation in Beliefs Between Citizens

The final part of the analysis is a multivariate investigation of social and psychological factors that might influence individuals' propensity to believe that astrology is a scientific subject. To do this, I use a variant of an ordinary least squares multiple regression model.

This analysis is primarily to examine individual level factors associated with beliefs about astrology. However, there is also likely to be heterogeneity of beliefs between the 25 European countries, even after taking into account individual characteristics. Modeling this situation calls for country to be

included as either a fixed or random effect. The first approach essentially gives each country its own dummy variable and regards each as a unique entity, so to speak. The second approach treats the countries in the data set as a random sample of potential countries that could have been included and estimates a single mean and variance for a continuous random variable that captures the heterogeneity across countries (Raudenbusch & Bryk, 2001). The model parameters can then be used to derive an estimate of each country's location in the distribution of this variable, a feature that would be useful for the present investigation.

If the individual level effects are uncorrelated with this country random effect, the random effects estimator is unbiased and preferred over the fixed effects one, because it is more efficient. If this assumption is not met, the fixed effects approach is appropriate. The result of a Hausman test (Hausman, 1978), which tests for the presence of this correlation, was highly nonsignificant ($\chi^2 = 5.86$, 17 *df*, $p = .99$), so the final model presented here uses the random effects estimator.[2]

Table 3 presents the estimates for the model predicting beliefs about astrology. Higher scores on the dependent variable indicate stronger belief that astrology is scientific. The included predictors account for 17% of the variance in beliefs. Turning first to Hypothesis 2a, the expectation was that there should be some correlation between beliefs about astronomy and beliefs about astrology because of semantic confusion. This is indeed the case here. The coefficient for astronomy is .35 with a very small standard error. Net of all other modeled influences, the more likely it is that citizens believe astronomy is scientific, the more likely they are to think that astrology is also scientific. It appears that the two subjects are not always well differentiated in European public imagination. In order to counter potential objections to this conclusion, I have included an additional variable ("all scientific") that is calculated as the mean of respondents' belief scores on all the other subjects except for horoscopes and homeopathy. Without this control, it could be argued that the correlation between astronomy and astrology is because of individual differences in the propensity to express the view that *anything* is scientific. The inclusion of this variable, though, does not eliminate the positive coefficient for astronomy.

Hypothesis 2b, if supported, would corroborate further this interpretation. I would not expect to see the same positive relationship between astronomy and horoscopes, precisely because they do not sound similar. To test this, I fitted the same model using the other split half of the sample and designating horoscopes as the dependent variable. The pattern of results is very close to that in Table 3 but, crucially, the coefficient for astronomy is very small,

Table 3. Random Effects Regression Estimates (Individual Characteristics), $N = 11{,}622$

	B	*SE*	*Z*	*p*
Age, years (reference category 15-24)				
25-39	−.12	.04	−2.66	.01
40-54	−.14	.04	−3.34	<.01
55+	−.22	.04	−5.22	<.01
Female	.06	.03	2.18	.01
Higher education	−.19	.03	−5.75	<.01
Professional or management occupation	−.08	.04	−1.89	.06
Large town or city dweller	−.10	.03	−3.04	<.01
Religious belief				
Catholic	.13	.04	3.70	<.01
God	.08	.04	2.02	.04
Spirit	.12	.04	3.21	<.01
Right wing political orientation	.01	.004	2.26	.02
Science knowledge				
Quiz score	−.09	.01	−17.42	<.01
Mentions hypothesis testing	−.25	.06	−4.55	<.01
Mentions measurement	−.21	.05	−4.52	<.01
Authoritarian	.22	.02	10.36	<.01
Astronomy scientific	.32	.01	26.80	<.01
All scientific	.24	.02	12.41	<.01
Intercept	1.18	.14	8.67	<.01

at .05 ($SE = .01$; $Z = 4.23$; $p < .01$), compared with the estimate in the astrology model. A formal test that the coefficients for astronomy in the two models are different was also conducted by refitting the two models as a single equation and adding an interaction between experimental condition (horoscopes or astrology samples) and astronomy. This term was, as expected, statistically significant and confirms that the difference in the effect of astronomy in each of the experimental conditions is unlikely to be because of chance. What this comparison between astrology and horoscopes conditions also suggests is that, apart from the semantic confusion between astronomy and astrology, Europeans seem to use the same basis for evaluation of both astrology and horoscopes, given that the same predictors have the same effects regardless of which name is used to identify the activity.

Hypothesis 3 concerns the relationship of scientific knowledge or literacy with perceptions of astrology. The expectation is that those who are better

endowed with civic scientific literacy will be better able to distinguish science from pseudoscience. Therefore, I expect positive coefficients for the knowledge measures. Looking at Table 3, one can see that this is indeed the case. The coefficients for all three knowledge variables are negative and statistically significant, meaning that the more knowledgeable a person is, the less scientific they believe that astrology is. To get a sense of the magnitude of the effects, if one compared a citizen who scored at the mean on the quiz and mentioned neither hypothesis testing nor measurement in their open-ended answer, their expected rating of astrology would be one point higher on the 5-point scale (in the "more scientific" direction) than a European mentioning both measurement and hypothesis testing and who scored at the maximum on the quiz, with all other variables held constant. Particularly interesting is the fact that science knowledge has an effect even after controlling for education.

Hypothesis 4 addressed in the analysis considers the relationship of authoritarian personality type with beliefs about astrology. The coefficient for the authoritarianism question is positive, at .22, and highly significant. For each one-point increase on the "importance of obedience" question the model predicts just less than a one-quarter point increase in the scientificness of astrology rating. So, controlling for all the other covariates, the predicted difference in belief about astrology between Europeans who do not think obedience is at all important to teach to children and those who think it very important is just slightly more than one scale point. Here, then, is empirical support for Adorno's linking of authoritarianism and openness to pseudoscience. Note again that this relationship is robust to the full range of other controls in the model, in particular age, education and conservative or right wing political orientation.

People who report believing in God or in a "spirit of some kind" are more likely to think astrology is scientific. Catholics are also more likely to express this view. These results are again in line with what one might expect from Adorno's account of the appeal of astrology to those who have a propensity to defer to higher authority of different kinds, including religion. I have no clear explanation for why Catholics should be more likely to be credulous of astrology, but it should be borne in mind that this finding of course controls for country as well as for individual characteristics. This means that religious denomination here is not simply a proxy for divergent beliefs of citizens from predominantly Catholic and non-Catholic European states.

The coefficients for the other sociodemographic variables are worth noting. Women are slightly more likely than men to think astrology is scientific, as are people who self-identify as being politically on the right. Those who live in large urban areas, who are better educated and in high status

Table 4. Variance Components for Intercept-Only and Full Models

	Intercept-Only Model		Full Model	
	Variance (*SE*)	Percentage of Total Variance	Variance (*SE*)	Percentage of Total Variance
Individual-level residual	2.08 (0.03)	87	1.80	92
Country residual	0.27 (0.08)	13	0.14	8

occupations are all less likely to accord astrology scientific credibility. A rather interesting finding is that older people tend to be less credulous of astrology. It is the youngest age group, 15 to 24 years, that regards astrology as most scientific. This invites speculation as to whether it is a lifecycle or a cohort effect we are seeing here. Do people become more skeptical as they age? Or are younger generations in general less skeptical than their parents? This is something for further research to establish.

Variation in Beliefs Between Countries

Table 4 shows the variance components estimates for both individual and country levels. This can be thought of as the proportion of unexplained, residual variation between individuals and between countries. The first two columns of the table show these variance estimates and the corresponding percentages for a model where only the intercept is fitted. In other words, it simply partitions total variation into within-group and between-group (individual and country). As little as 13% of the variation in beliefs about astrology is systematically related to country, while the remainder is because of interindividual variation. When the full model, with all the independent variables, is estimated, the proportion due to country drops by around on third, to 8%. This indicates that some of the apparently systematic country variation is due to compositional differences in populations on the individual characteristics entered into the model. In general terms, it would appear that the socialpsychological factors that influence beliefs about astrology and science across Europe are broadly common to citizens from all countries.

Nevertheless, this is not to say that there is no systematic difference between countries at all. One way of exploring this is to obtain estimates of the unobserved country-level random effect variable and to compare estimates across countries. These estimates are also known as “empirical Bayes estimates” (Raudenbusch & Bryk, 2001). Figure 4 shows standardized random effects estimates for each of 25 European member states. These can be

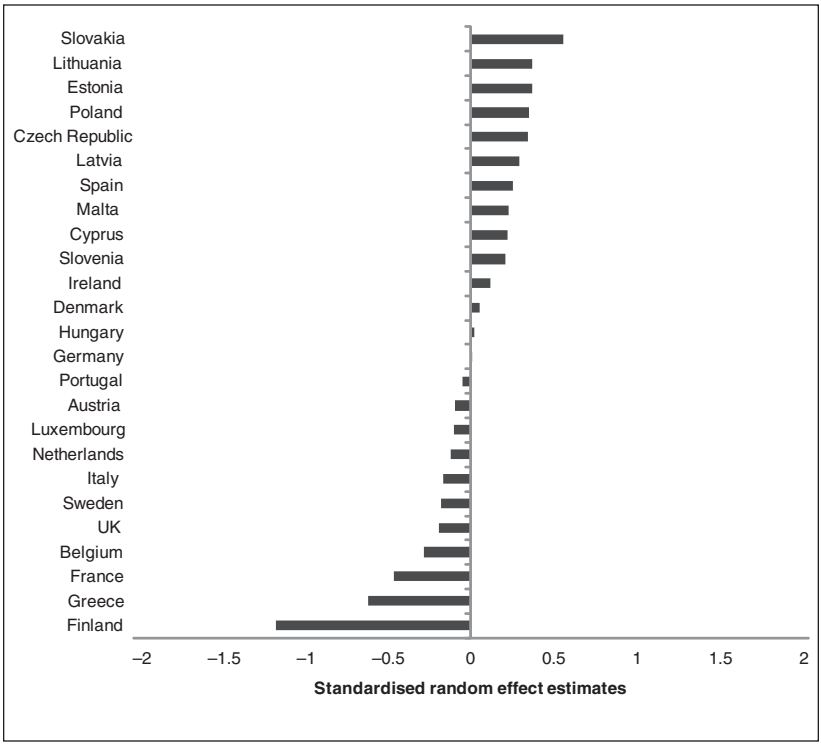

Figure 4. Standardized random effect estimates for 25 European countries

thought of as unexplained country level residuals, expressed in standard deviations from the mean (zero), after taking into account all the individual level variables in the model. There is a surprisingly clear pattern to the variation. Controlling for the individual characteristics of citizen, all the former Eastern bloc countries are more accepting of astrology as being scientific than the model would predict, while the majority of Western European states have more skeptical citizens than would be expected given the individual attributes of their citizens.

Conclusion

Europeans have a range of beliefs about astrology and its status as a scientific or quasi-scientific subject. The evidence from the experiment and from the observational data show that there is considerable blurring over what the

term means. There is a clear confusion between astronomy and astrology. There are also widely differing evaluations of horoscopes as compared with astrology in terms of their scientific credibility, even though one might consider the two as functionally equivalent to most intents and purposes. Astrology is regarded as more scientific than horoscopes but interestingly, the correlates of credulity in both of these are patterned in exactly the same way. In other words, the same types of citizen are likely to regard astrology and horoscopes as more scientific. The only major difference between regression models predicting beliefs was that the effect of astronomy belief was far greater for astrology than for horoscopes.[3] Perhaps previous research on science literacy that has gauged the credulousness of citizens about astrology has led to rather more pessimistic conclusions than are really warranted.

However, science literacy clearly makes a difference. Net of a range of other potential confounding influences, the better is one's understanding of scientific terms and concepts, as well as factual knowledge of science, the better one is able to distinguish science from pseudoscience. This immunizing effect of scientific knowledge is perhaps not a surprising finding, but one that underlines the utility of these survey indicators in distinguishing between modes of citizen reasoning about science and confirms the importance of scientific literacy in helping Europeans make informed judgments about the validity of pseudoscientific claims. It is interesting too that this formal science knowledge makes a difference over and above the effect of education more generally. The implication is that being well educated and having a college degree is not enough on its own necessarily to allow citizens to distinguish pseudoscience from science. While this study has not focused on health and consumer choices, it is quite possible that the model presented here holds across a range of pseudoscientific domains in which citizens are confronted with the need to make informed choices.

The result that authoritarian-type values are associated with greater credulity toward astrology is fascinating and in line with Adorno's prediction. Whether it is because of a general propensity to defer to any kind of authority, or whether it is bound up with antirational culture in the way that Adorno hypothesized is open to question. Furthermore, research could profitably be directed toward a greater elaboration of the mechanisms underlying the observations made in the present study. Perhaps linked to this finding are the systematic country variations. Former Eastern bloc states seem to be more accepting of astrology and more likely to consider it scientific. This holds true even conditioning on science literacy, religion, education, political orientation, and values. Citizens of these countries have a recent history of state

and civil society being organized along authoritarian lines, and this cultural norm may be reflected in the readier acceptance of astrology in Eastern Europe, over and above that because of variation in individual personality traits.

This investigation has examined some of the correlates and putative causes of different beliefs about astrology and its relationship with science. One notable omission in the set of correlates examined here is the absence of any communication variables, such as media use and attentiveness. This was dictated by the lack of suitable items in the Eurobarometer survey and it remains an interesting question what the effect of attention to science coverage in the media, and of regular attention to personal horoscopes, might be on beliefs about astrology.

As a final note, it should probably be borne in mind that for most people, reading a horoscope is a leisure activity and not one of central importance either. Nevertheless, by understanding how Europeans differ in their perceptions of astrology and horoscopes, it is possible to gain some insight into the bases of how citizens evaluate scientific and pseudoscientific claims more generally.

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Notes

1. A sensitivity analysis showed that a more detailed breakdown of religious denomination has no impact on the coefficients for other variables in the model.
2. A 5-point Likert-type scale is not strictly a continuous variable, and therefore ordinary least squares may not be appropriate. To assess the sensitivity of the results to this, I also ran the analysis with a random effects ordered logit model (Rabe-Hesketh, Skrondal, & Pickles, 2002). The results of this alternative parameterization of the model show no differences in the sign or statistical significance of any coefficient except for "belief in God," which becomes marginally nonsignificant.
3. This could be viewed as evidence for semantic confusion, although, as an anonymous referee pointed out, it may also be that astrology conforms on the surface to a naive view of what science is and it is this, rather than confusion with astronomy, that leads to its tendency to be evaluated as more scientific.

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